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(54) Packet multiplexing system

(57) To provide a simply-configured multiplexing system which detects multiplexing errors, the PES packetizing modules 11, 21, and 31 packetize elementary streams (ES) to produce packetized elementary streams (PES), and the TS/PS packetizing module 41 multiplexes packetized elementary streams (PES) to produce transport streams (TS) or program streams (PS). The comparators 13, 23, 33, 45. 46, and 47 each compare an non-packetized elementary stream (ES) or a packetized elementary stream (PES) stored in the FIFO memory with the packetized elementary stream (ES) or packetized elementary stream (PES) from the PES packetizing module 11, 21, 31, and 41. Based on the comparison result, the control module 5 detects an error in the PES packetizing module 11, 21, 31, and 41.

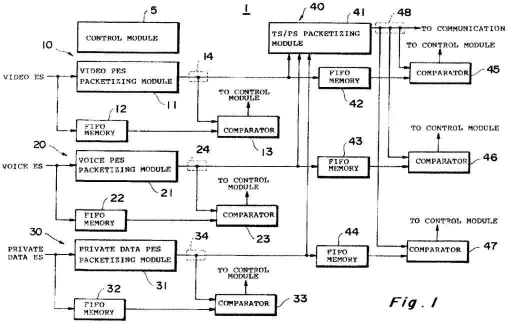

Fig. 1

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Description

BACKGROUND OF THE INVENTION

1. Field of the invention

The present invention relates to a packet multiplexing system which divides input data into a plurality of packets to multiplex the packets for output. The invention relates particularly to a packet multiplexing system which compares input data with the corresponding data in a packet.

2. Description of the prior art

MPEG2 (Moving Picture Expert Group 2), one of encoding systems for compressing moving pictures, has been used to generate packets of various types of data such as image data, voice data, text data, and so forth. These packets are multiplexed, recorded on recording media, and sent over communication lines. MPEG2 defines the recommendations for a unit receiving multiplexed packets, that is a de-multiplexing system, but not for a multiplexing system. Therefore, a multiplexing system may be designed as long as a de-multiplexing system satisfies the recommended performance.

A conventional packet multiplexing system has the video PES packetizing module 61, voice PES packetizing module 62, private data PES packetizing module 63, and TS/PS packetizing module 64 as shown in Fig. 2. The three packetizing modules, video PES packetizing module 61, voice PES packetizing module 62, and private data PES packetizing module 63, packetize elementary streams (ES), such as video data, voice data, and private data, respectively, which are sent from the encoding module (not shown). The packetizing modules 61, 62, and 63 then generate packetized elementary streams (PES) shown in Fig. 3. Next, the TS/PS packetizing module 64, in turn, packetizes those PESs, generate transport streams (TS) or program streams (PS) shown in Figs. 4 and 5, and outputs them.

In addition, this packet multiplexing system compares non-multiplexed data and multiplexed data in the stream to check if input data is set up correctly in the stream. More specifically, the packet multiplexing system has a circuit (not shown) functionally equivalent to the packet de-multiplexing module which should be in a de-multiplexing system. This circuit, almost as large as the multiplexing system in size, de-multiplexes the multiplexed transport streams (TS) or program streams (PS) into elementary streams (ES); that is, video data, voice data. and private data elementary streams (ES), and then checks if the de-multiplexed elementary streams (ES) match the original elementary streams (ES).

However, the monitor circuit in the conventional packet multiplexing system is too large and expensive, which leads to difficulties to provide a compact and low-cost packet multiplexing system.

SUMMARY OF THE INVENTION

To solve the above problem, a packet multiplexing system according to the present invention generates, based on input data, a packet containing the input data and a header. and compares the data in the generated packet and the input data. This allows determination of whether input data matches data in a generated packet. Therefore, the packet multiplexing system according to this invention is compact and low-cost as compared with the conventional packet multiplexing system.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description and the accompanying drawings below of the preferred embodiments of the invention.

In the drawings:

Fig. 1 is a block diagram showing the configuration of a multiplexing system according to the first embodiment of this invention;

Fig. 2 is a block diagram showing the configuration of a conventional multiplexing system;

Fig. 3 is a diagram showing the format of a packetized elementary streams (PES);

Fig. 4 is a diagram showing the configuration of a transport stream (TS);

Fig. 5 is a diagram showing the configuration of a program stream (PS); and

Fig. 6 is a block diagram showing the configuration of a multiplexing system according to the second embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The multiplexing system according to the present invention may be employed to the multiplexing module of an encoder which multiplexes image data, voice data, and private data compression-encoded using a compression technology such as MPEG2.

<First Embodiment>

In the first embodiment, the present invention is applied to the multiplexing module of such an encoder. As shown in Fig. 1, this multiplexing module includes three packetizing systems which packetize data sent from the encoding module of the encoder. Three packetizing systems are: the video packetized elementary stream (PES) packetizing system 10 which packetizes video data, voice PES packetizing system 20 which packetizes voice data, and private data PES packetizing system 30 which packetizes private data. In addition, the multi-

plexing module has the TS/PS packetizing system 40 which multiplexes the packetized elementary streams sent from the PES packetizing systems 10, 20, and 30.

The video PES packetizing system 10 has the video PES packetizing module 11 to packetize the video data elementary stream ES, the First In First Out (FIFO) memory 12 to store non-packetized video data, and the comparator 13 to compare non-packetized video data with packetized video data. The voice PES packetizing system 20 and the private data PES packetizing system 30 each have the same configuration as that of the video PES packetizing system 10. More definitely, the voice PES packetizing system 20 and the private data PES packetizing system 30 have the voice PES packetizing module 21 to packetize voice data elementary streams and the private data PES packetizing module 31 to packetize private data elementary streams, respectively, the FIFO memory 22 to store non-packetized voice data and the FIFO memory 32 to store non-packetized private data, respectively, and the comparator 23 to compare non-packetized voice data and packetized voice data and the comparator 33 to compare non-packetized private data and packetized private data.

Each of the PES packetizing modules 11, 12, and 13 adds a header and other information to an elementary stream (ES) sent from each encoding module to form a packetized elementary stream (PES) shown in Fig 3. The length of a packetized elementary stream (PES) is variable.

The PES packetizing module 11, 21, or 31 requires some time to process an elementary stream (ES) to form a packetized elementary stream (PES). This results in a time delay between time when an elementary stream (ES) is sent to the packetizing module 11, 21, or 31 and time when a packetized elementary stream (PES) is produced To compare a packetized elementary stream (PES) with an elementary stream (ES), the payload field of the packetized elementary stream (PES), shown in Fig. 3, and the elementary stream (ES) must be simultaneously sent to the comparator 13, 23 or 33, respectively. In short, each of FIFO memories, 12, 22, or 32, need only be large enough to contain an elementary stream (ES) that is sent within the delay time of the PES packetizing modules 11. 21, or 31; if the input data rate is "V" and the delay time is "T", then the FIFO memory size "M" need only be at least "V" x "T".

To synchronize a packetized elementary stream (PES) with an elementary stream (ES), the FIFO memory delays the elementary stream (ES) by a predetermined time (e.g , the sum of the time required to create the header and the time to create the packetized elementary stream (PES)). However, the time required to generate a packetized elementary stream varies from time to time. So, it is desirable that, instead of predetermining a time for the FIFO memory, the packetizing module monitors the generation of a packetized elementary stream and sends an elementary stream to the FIFO memory when the packetized elementary stream is generated.

The TS/PS packetizing system 40 has the TS/PS packetizing module 41 to multiplex packetized elementary streams (PES) sent from the PES packetizing modules 11, 21, and 31 to form a transport stream (TS) shown in Fig. 4 or a program stream (PS) shown in Fig 5, the FIFO memories 42, 43, and 44 to contain non-multiplexed packetized elementary streams (PES) from the above-mentioned PES packetizing modules 11, 21, and 31. and the comparators 45, 46, and 47 to compare the non-multiplexed packetized elementary streams (PES) and the packetized elementary streams (PES) multiplexed by TS/PS packetizing module 41.

A transport stream (TS) contains one or more packetized elementary streams (PES) divided into data items each of a specified length. Thus, depending upon the length of a packetized elementary stream (PES), a plurality of packetized elementary streams (PES) form one transport stream (TS) or, conversely, one packetized elementary stream (PES) extends across a plurality of transport streams (TS). A program stream (PS), which is created by adding a header to a packetized elementary stream (PES), is never divided.

Because multiplexing requires some time, there is a time delay between time when a packetized elementary stream (PES) is sent to the TS/PS packetizing module 41 and time when a transport stream (TS) or a program stream (PS) is output Therefore, as with the FIFO memories 12, 22, and 32, the FIFO memories 42, 43, and 44 each must be large enough to hold packetized elementary streams (PES) that are output during the delay time in order to send them to the comparators 45, 46, and 47 at the same time a transport stream (TS) or a program stream (PS) is sent from the TS/PS packetizing module 41 to the comparators 45, 46, and 47.

In the multiplexing module with a configuration described above, the elementary streams (ES) of video data, voice data, and private data are sent from the encoding module to the video PES packetizing module 11, voice PES packetizing module 21, and private data PES packetizing module 31 before being packetized. The elementary streams (ES) are also sent to the FIFO memories 12, 22, and 32.

The video PES packetizing module 11 adds a header and some other information to the elementary stream (ES) of the received image data to form a packetized elementary stream (PES). It then sends this packetized elementary stream (PES) to the comparator 13 and the FIFO memory 42.

From the packetized elementary stream (PES) sent from the video PES packetizing module 11, the comparator 13 extracts the part corresponding to the elementary stream (ES) and compares it with the elementary stream (ES) before packetizing sent from the FIFO memory 12. If there is no error in the packetized elementary stream (PES) generated by the video PES packetizing module 11, the non-packetized elementary stream (ES) should match the packetized elementary

stream (ES), if there is an error, the non-packetized elementary stream (ES) should not match the packetized elementary stream (ES). In the latter case, the comparator 13 informs the control module of the condition.

The other two packetizing modules, the voice PES packetizing module 21 and the private data PES packetizing module 31, do the same processing, More specifically, they add a header to a received elementary stream (ES) to form a packetized elementary stream (PES) and sends it to the comparator 23 and the FIFO memory 43 , or to the comparator 33 and the FIFO memory 44, respectively.

From the packetized elementary stream (PES) sent from the video PES packetizing module 21 or 31, the comparator 23 or 33 extracts the part corresponding to the elementary stream (ES) and compares it with the non-packetized elementary stream (ES) sent from the FIFO memory 22 or 32 and informs the control module 5 of the result.

In this manner, the control module 5 receives the result of comparison between the non-packetized elementary stream (ES) and the packetized elementary stream (ES). This allows the control module 5 to check whether or not an error was generated during execution of the video PES packetizing modules 11, 12, or 13.

A packetized elementary stream (PES) from the PES packetizing module 11, 21, or 31 is sent to the TS/PS packetizing module 41 The TS/PS packetizing module 41 multiplexes a packetized elementary stream (PES) from each of the video PES packetizing modules 11, 21, and 31 to form a transport stream (TS) or a program stream (PS), and sends this transport stream (TS) to the communication line and to each of the comparators 45, 46, and 47.

From a transport stream (TS) or a program stream (PS), the comparator 45 extracts the part corresponding to the packetized elementary stream (PES) of video data and compares it with the non-multiplexed packetized elementary stream (PES) stored in the FIFO memory 42 and informs the control module of the comparison result. When the comparator 45 receives a transport stream (TS) from the TS/PS packetizing module 41, it restores an individual packetized elementary stream (PES) by combining or dividing packetized elementary streams (PES) contained in the transport stream (TS). It then extracts a restored packetized elementary stream (PES). This is because each transport stream (TS) contains a part of a packetized elementary stream (PES) or a combination of a plurality of packetized elementary streams (PES). When the comparator 45 receives a program stream (PS) from the TS/PS packetizing module 41, it deletes the header from the program stream (PS) and extracts the packetized elementary stream (PES). Then, the comparator 45 compares the extracted packetized elementary stream (PES) with the non-multiplexed packetized elementary stream (PES) stored in the FIFO memory 42 and sends the comparison result to the control module 5.

The other two comparators 46 and 47 do the same processing. That is, the comparator extracts voice data or private data from a transport stream (TS) or a program stream (PS), compares the extracted data with the non-multiplexed packetized elementary stream (PES) stored in the FIFO memory 43 or 44, and informs the control module 5 of the comparison result.

Based on the comparison result sent from each of comparators 13, 23, 33, 45, 46, and 47, the control module 5 checks if an error occurred in the PES packetizing modules 11, 21, 31 or in the TS/PS packetizing module 41 and, based on the result, controls the operation of the packetizing module 11, 21, 31, or 41. For example, when there is no error in the packetizing module 11, 21, 31, or 41, the control module 5 treats the output from the packetizing module 11, 21, 31, or 41 as valid; conversely, if there is an error in the packetizing module 11, 21, 31, or 41, the control module 5 treats the output as invalid. Or, the control module 5 may be designed so that it can tell the packetizing module to re-generate the transport stream (TS) or program stream (PS) when there is an error in the packetizing module 11, 21, 31, or 41.

As described above, this system has the FIFO memories 12, 22, and 32 to compare an non-packetized elementary stream (ES) with that a packetized elementary stream (ES). The result indicates whether an error occurred in any of the PES packetizing modules. This system also has the FIFO memories 42, 43, and 44 to compare a non-multiplexed packetized elementary stream PES with a multiplexed packetized elementary stream PES. The result indicates whether an error occurred in the TS/PS packetizing module 41. Compared with a system with a separate de-multiplexing module, this simply-configured system detects a data error in the payload field that may occur in the multiplexing module, increasing reliability.

In addition, use of the FIFO memories eliminates the need for the comparators 13, 23, 33, 45, 46, and 47 or the control module 5 to manage the location of an elementary stream (ES) or a packetized elementary stream (PES), reducing the processing load.

This multiplexing module also has a FIFO memory and a comparator for each elementary stream (ES) and a packetized elementary stream (PES), thus enabling the control module to identify which packetizing module has an error.

<Second Embodiment>

In the second embodiment, the present invention is applied to a multiplexing system which has a plurality of multiplexing modules and which selects the output from an error-free multiplexing module. As shown in Fig. 6, this multiplexing system has two sets with the configuration shown in Fig. 1, each set including the multiplexing module 1 and the control module 5. This system also has the selection control module 52 to select one of the

multiplexing modules, depending upon the error output from the control modules 5a and 5b of the multiplexing modules 1a and 1b.

The comparators 13, 23, 33, 45, 46, and 47 in each of the multiplexing modules 1a and 1b send to the control modules 5a and 5b the result of comparison between a non-packetized elementary stream (ES) and a packetized elementary stream (ES) as well as the result of comparison between a non-multiplexed packetized elementary stream (PES) and a multiplexed packetized elementary stream (PES).

Each of the control modules 5a and 5b checks the comparison output from the comparators 13, 23, 33, 45, 46, and 47 to check to see if there is a comparison error and, if it finds an error, informs the selection control module 52 of the error. Based on the information from the control modules 5a and 5b, the selection control module 52 checks if an error occurred in the multiplexing modules 1a and 1b. The selection control module 52 then controls the TS/PS packetizing module 41 in the multiplexing modules 1a and 1b in such a way that a transport stream (TS) or a program stream (PS) from an error-free multiplexing module 1a or 1b is output to the communication line or some other unit.

For example, an error in one of the packetizing modules 11, 21, 31, and 41 shows that a packetizing error or a multiplexing error occurred and that the non-packetized elementary stream (ES) or packetized elementary stream (PES) and the packetized elementary stream (ES) or packetized elementary stream (PES) differ. When one of the comparators 13, 23, 33, 45, 46, and 47 finds this difference, the control module 5a or 5b finds an error, causing the selection control module 52 to select an error-free multiplexing module 1a or 1b. Therefore, this multiplexing system is able to output an error-free transport stream (TS) or a program stream (PS), increasing the reliability of the multiplexing module.

Another advantage of this system is that, when an error occurs in both multiplexing modules 1a and 1b, the control modules 5a and 5b detect the number of errors in each comparator to allow the selection control module 52 to send the output sent from the multiplexing module 1a or 1b which has less errors. This prevents a transport stream (TS) or a program stream (PS) from being disrupted even when an error occurs in both multiplexing module 1a and 1b.

In the above embodiments, a FIFO memory is used to store packets to be multiplexed. This memory may be replaced, as necessary, by another type of memory.

The packet multiplexing system according to the present invention compares the original input data with the input data in the packet using the comparison means to check whether those input data are similar or not. Accordingly, the packet multiplexing system can detect errors lying therebetween without the packet de-multiplexing module serving as the monitor circuit for the input data in the multiplexing system, unlike the conventional arts. As described above, the de-multiplexing module is so large and expensive; a compact and low-cost packet multiplexing system can be available.

Furthermore, the packet multiplexing system synchronizes the original input data with the input data in the packet using the synchronization means, which adjusts output timing of the original input data. Therefore, the packet multiplexing system can detect difference between the original input data and the input data in the packet based on those data synchronized with each other.

Moreover, the packet multiplexing system adjust the output timing of the original input data by a predetermined delay time or a time necessary for packetizing of the original input data, for the purpose of the synchronization. As a result, the packet multiplexing system can accurately confirm the difference between the original input data and the input data in the packet.

For an application of the packet multiplexing system, the packet multiplexing equipment is constructed of a plurality of the packet multiplexing system. The multiplexing equipment detects any faults of one among those packet multiplexing systems, thus selecting one of the others capable of regular operation. Consequently, even though one of those packet multiplexing systems malfunctioned, the multiplexing equipment can continue the multiplexing of the data using another packet multiplexing system free of the fault, thereby leading to enhancement of reliability of the multiplexing.

Claims

1. A packet multiplexing system comprising:

   packet generation means for generating from input data a packet containing the input data and a header; and
   comparison means for comparing the input data with the input data in the packet to check difference therebetween.

2. A packet multiplexing system as set forth in claim 1 further comprising:

   synchronization means for synchronizing the input data with the input data in the packet,
   wherein the comparison means compares the synchronized input data with the input data in the packet to check difference therebetween.

3. A packet multiplexing system as set forth in claim 2 wherein the synchronization means has delay means for allowing the input data to be output with delay time.

4. A packet multiplexing system as set forth in claim 3, wherein the packet generation means has monitor means for monitoring generation of the packet

and for outputting a signal indicating the completion of the generation of the packet and size of the header, and the delay means allows the input data to be output according to the signal.

5. A packet multiplexing system as set forth in claim 2, wherein the synchronization means has output adjustment means for outputting the input data upon expiration of sum of a first time for the packet generation means to generate the packet and a second time corresponding to header of the packet from receipt time of the input data.

6. A packet multiplexing system comprising:

first packet generation means for generating from input data a first packet containing the input data and a first header;
second packet generation means for generating from the first packet a second packet containing the first packet and a second packet containing a second header;
first comparison means for comparing the input data with the input data in the first packet to check difference therebetween; and
second comparison means for comparing the first packet with the first packet in the second packet to check difference therebetween.

7. A packet multiplexing system comprising a first packet multiplexing system and a second packet multiplexing system wherein the first packet multiplexing system comprising:

first packet generation means for generating from input data a first packet containing the input data and a header; and
first comparison means for comparing the input data with the input data in the first packet to check difference therebetween: and wherein, the second packet multiplexing system comprising:
second packet generation means for generating from the input data a second packet containing the input data and a second packet containing the input data and the header; and
second comparison means for comparing the input data with the input data in the second packet to check difference therebetween, and the first packet multiplexing system and the second packet multiplexing system are used selectively based on comparison results of the first comparison means and the second comparison means.

8. A packet multiplexing system as set forth in claim 7, wherein the first packet multiplexing system further comprises first synchronization means for synchronizing the input data with the input data in the first packet, and
the second packet multiplexing system further comprises second synchronization means for synchronizing the input data with the input data in the second packet and wherein

the first comparison means compares the synchronized input data with the input data in the first packet and
the second comparison means compares the synchronized input data with the input data in the second packet.

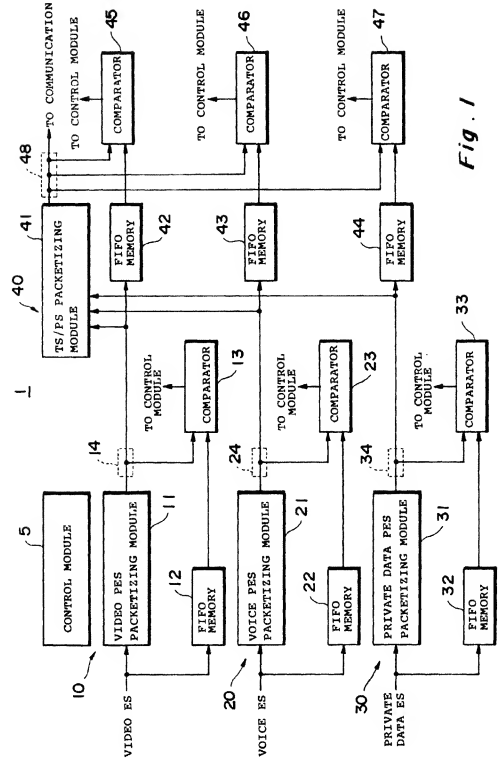
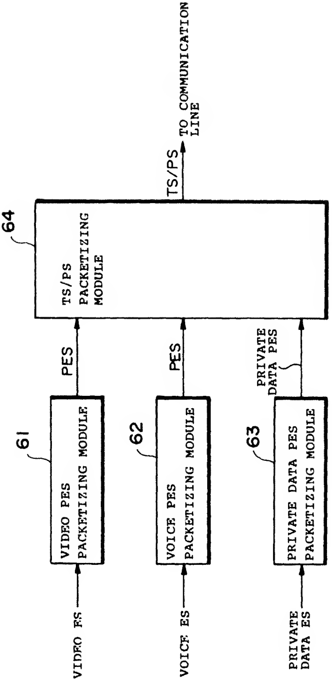

1
5
CONTROL MODULE
10
VIDEO ES
11
VIDEO PES PACKETIZING MODULE
12
FIFO MEMORY
13
COMPARATOR
TO CONTROL MODULE
14
20
VOICE ES
21
VOICE PES PACKETIZING MODULE
22
FIFO MEMORY
23
COMPARATOR
TO CONTROL MODULE
24
30
PRIVATE DATA ES
31
PRIVATE DATA PES PACKETIZING MODULE
32
FIFO MEMORY
33
COMPARATOR
TO CONTROL MODULE
34
40
41
TS/PS PACKETIZING MODULE
42
FIFO MEMORY
43
FIFO MEMORY
44
FIFO MEMORY
45
COMPARATOR
TO CONTROL MODULE
46
COMPARATOR
TO CONTROL MODULE
47
COMPARATOR
TO CONTROL MODULE
48
TO COMMUNICATION

Fig. 1

Fig. 2

PRIOR ART



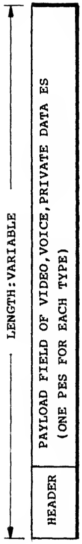
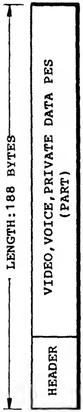

LENGTH:VARIABLE
HEADER
PAYLOAD FIELD OF VIDEO,VOICE,PRIVATE DATA ES
(ONE PES FOR EACH TYPE)

Fig. 3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HEADER
VIDEO,VOICE,PRIVATE DATA PES
(PART)

Fig. 4

Fig. 5

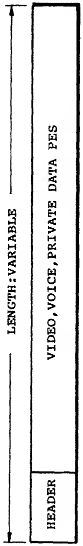
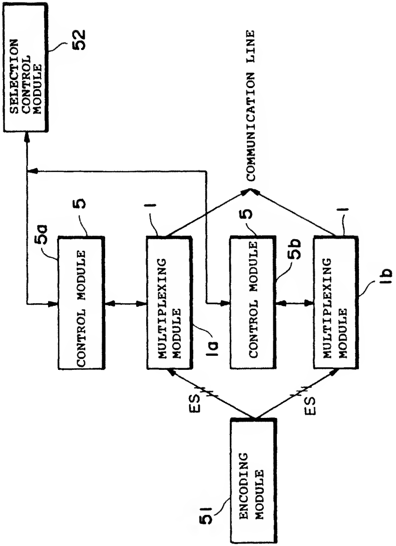


Fig. 6


SELECTION CONTROL MODULE
52
COMMUNICATION LINE
CONTROL MODULE
5a
5
MULTIPLEXING MODULE
1
1a
CONTROL MODULE
5
5b
MULTIPLEXING MODULE
1
1b
ES
ES
ENCODING MODULE
51